

## Development of a Computational Program for Uncertainty Evaluation of Event Scenario in a PSA Model -MOSAIQUE

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### 1. Introduction

MOSAIQUE was developed to facilitate the uncertainty analysis of a thermal-hydraulic calculation. There are numerous parameters affecting calculation results of the thermal-hydraulic (T/H) code. After the determination for the parameter which will participate in the uncertainty analysis, the probability density function of the parameter is given according to the nature of behavior in the parameter. These input generation and repeated calculations are tedious tasks. MOSAIQUE can perform these tasks automatically.

### 2. Program Structure

In this section some of the program structure and calculation manners are described

#### 2.1 Overall Structure

MOSAIQUE is composed of two main modules. One is for the generation of sampling input and maintaining sampled input and output files. This is named as master unit (MU). The other is for the allocation of calculation to the PCs connected to the intranet. This is named as client unit (CU).

The MU has the following functions.

- Read base input and record PDF information for selected numerical value
- Input file generation
- Save run information to master DB

The CU has the following functions

- Read run information from the master DB and assign each calculation to the PCs
- Collect output files

The overall structure is shown in Figure 1.

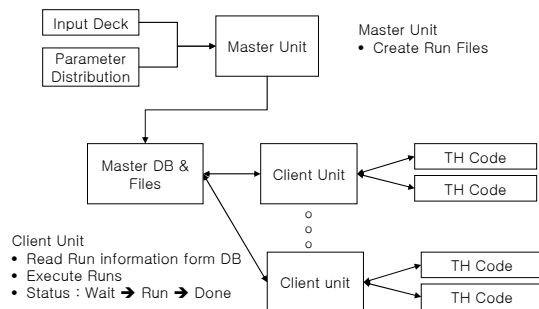


Fig. 1. Overall structure of the MOSAIQUE

#### 2.2 Input sampling

Most of T/H computer codes use a text file format as an input to the code. RELAP5 [1] and MARS [2] are the representative T/H computer code. Figure 2 shows a part of example used in the MARS code transformed to MOSAIQUE input generation module. As shown in the figure, the input is composed of comment sentences and code for a component used in the simulations. The code is also composed of numeric or alphabetical sentence. The MOSAIQUE use spread sheet style to discriminate each word. Usually, most of the parameter under sampling is described with a numerical digit.

Once the original input was changed with spread sheet files, user can choose (double click a value) a numerical value related to a parameter. Figure 2 shows a window when an user choose a value. With this window, a user can specify its stochastic characteristics. These include name of the numerical value, kind of distribution, and its characteristics parameters. Currently, a normal, lognormal, gamma distribution can be utilized with the MOSAIQUE.

Input Model	1	2	3	4	5	6	7	8
48	315	htemp	170001008	0.0	1500.0	3	5	'Cladding te
49	316	htemp	170001208	0.0	1500.0	3	6	'Cladding te
50	317	pmvvel	366	0.0	200.0	7	1	'RCP1 spee
51	318	pmvvel	466	0.0	200.0	7	2	'RCP2 spee
52	-----							
53	-----							
54	-----							
55	-----							
56	-----							
57	351	p	290080000	0.0	20.e6	1	1	'PZR Pres
58	352	p	900010000	0.0	20.e6	1	2	'C/H Pres
59	353	voidf	170020000	0.0	1	2	1	'core voidf
60	354	voidf	170040000	0.0	1	2	2	'core voidf

Fig. 2. Input transformation using spread sheet

Frequently, there is a case when a parameter is related with multiple numerical values in the input files. Furthermore, the numerical value may have some functional relation. At this case, a sampled value should be used in the entire value and the numerical value should have functional relation. For this purpose, the MOSAIQUE provide "equation function".

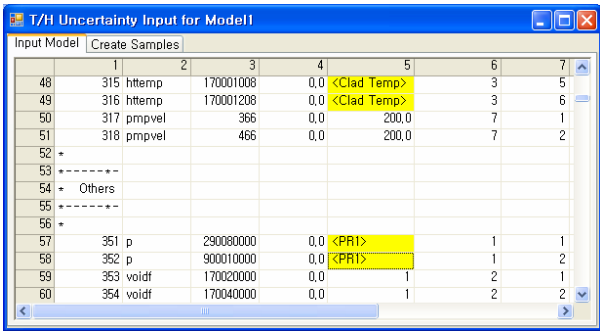


Fig. 3. Parameters choosing and their representation in input sampling module of the MOSAIQUE

### 2.3 Input Generation

Once the information for the parameters is assigned to the variables in the base input file, MOSAIQUE performs input generation according to the user defined sampling number by sampling each parameter. The sampled input is then saved to the master DB. Figure 4 shows the input generation process. MOSAIQUE samples each parameter from their given PDF. The first row shows parameter selected, which there are six numerical values are shown in the figure. In the figure, we sampled 52 sample input for example. The second row shows nominal value in the base input. N'th input is then generated by changing numerical value described in N'th row in the figure.

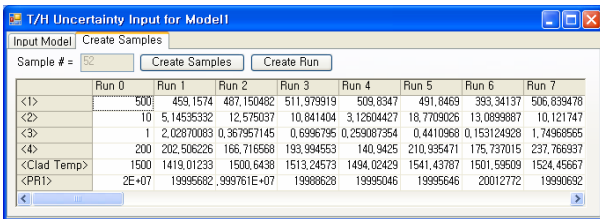


Fig. 4. Sampled input using Monte-Carlo random sampling

### 2.4 Assignment of calculation to a PC

Master DB plays a central role in assigning calculation load to a client PC. It was made by using Microsoft Access DB. The structure is composed of five fields. Table 1 shows an example of the master DB. As shown in the table, client PC name as Lims completed 1 run and are calculation 2 runs (2~4 row in table 1). PC named as Client 1 is calculating 4 runs. The other runs (9~10 row) are not assigned to any PC

Table I: Example run of CU in MOSAIQUE

Model	Run No	Client PC	Status	Input File
SLOCA-3	#Run-000	Lims	Done	a0in.txt
SLOCA-3	#Run-001	Lims	Running	a1in.txt
SLOCA-3	#Run-002	Lims	Running	a2in.txt
SLOCA-3	#Run-003	Client 1	Running	a3in.txt

SLOCA-3	#Run-004	Client 1	Running	a4in.txt
SLOCA-3	#Run-005	Client 1	Running	a5in.txt
SLOCA-3	#Run-006	Client 1	Running	a6in.txt
SLOCA-3	#Run-007		Waiting	a7in.txt
SLOCA-3	#Run-008		Waiting	a8in.txt

The key field for assigning calculation load is the “status” since the client PC searches for the state of waiting from master DB and calculate the run after changing the status. If the calculation is completed, then client unit changes the status as “done”

### 2.5 Project management

MOSAIQUE can produce multiple projects in its workspace A project means a set of calculations from the chosen parameter and its calculation number. Figure 5 shows an example of projects in a workspace.

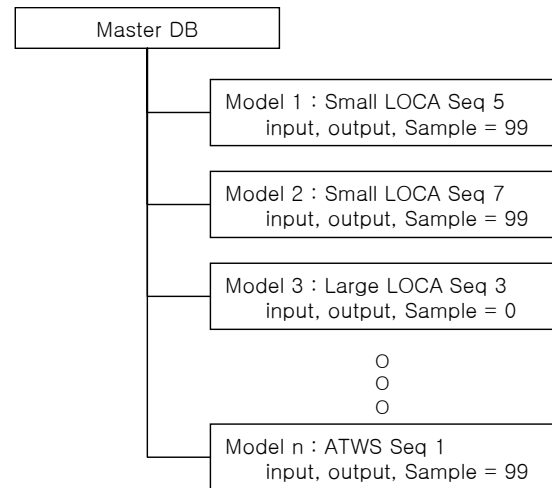


Fig. 5. Project structure of the MOSAIQUE

## 3. Conclusions

MOSAIQUE was developed to facilitate the uncertainty analysis of a thermal-hydraulic calculation.

MOSAIQUE may apply any T/H code if it uses test style input format. Also, calculation resource can be properly assigned in multiple PCs using intranet.

## REFERENCES

- [1] Jeong, J. -J., Ha, K. S., Chung, B. D., Lee, W. J., “ Development of A Multi-dimensional Thermal-Hydraulic System Code, MARS 1.3.1,” Annals of Nuclear Energy 26(18), 1161-1642 (1999)
- [2] RELAP5/MOD3.3 Code Manual Vol. III, Developmental Assessment, Information Systems Laboratories, Inc. Rockville, Maryland/Idaho Falls, Idaho (2003)